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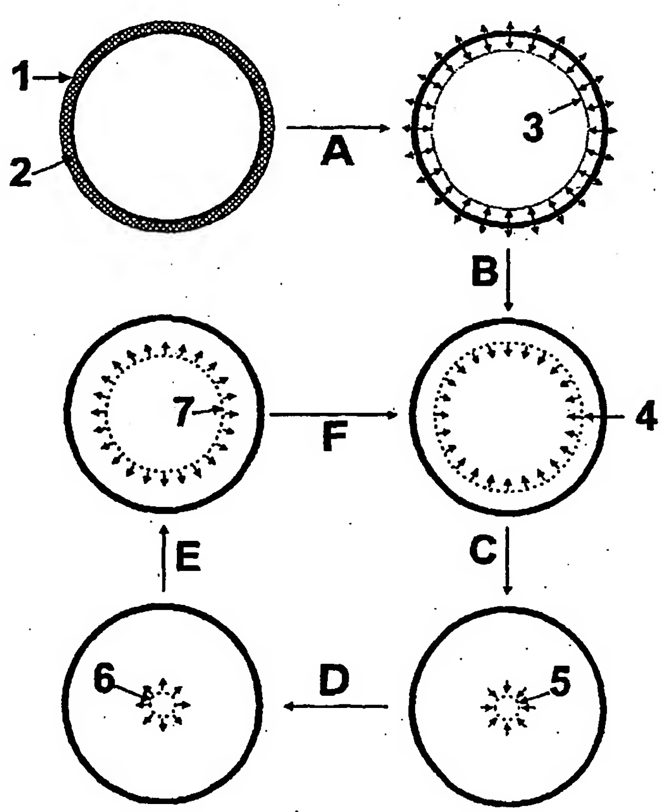

(57) Abstract: A method of creating fusion and a fusion reactor are disclosed. The reactor comprises a vessel (2) which is initially surrounded by an explosive material (1). The explosive material (1) is detonated to create an imploding shock wave (3) which implodes towards a focal point of the vessel, thereby heating and pressurising fuel in the vessel to a temperature at which fusion occurs. The creation of fusion releases energy and also an expanding shock wave which is reflected from the inner surface of the vessel to again produce an imploding shock wave which implodes towards the focal point of the vessel, thereby again heating and pressurising fuel to create further fusion. This process continues in an oscillating pulse fashion so as to continuously produce fusion and a shock wave which is reflected from the vessel to again produce fusion. The vessel may be spherical, ellipsoidal, hemi-ellipsoidal or tubular in shape.

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FUSION REACTOR AND METHOD FOR GENERATING ENERGY BY FUSION

Field of the Invention

This invention relates to a fusion reactor and to a method of generating energy by fusion.

Background Art

As is well known, conventional commercial systems for generating nuclear energy comprise fission reactors. Fission reactors have well documented disadvantages, the most important of which relate to the ecological impact of collecting and storing spent fuel from the reactors.

Generating nuclear energy by fusion is a much more desirable technique. Because fusion occurs when two nuclei fuse together to form a heavier nucleus with a release of energy, fusion reactors are not subject to the same problems as fission reactors. However, in order for fusion to occur, very high pressures and temperatures, generally in the order of millions of degrees, are required.

Current fusion technology uses clusters of high powered lasers to simultaneously bombard a speck of frozen hydrogen isotopes, to create an implosion yielding high pressures and temperatures. Successful fusion ignition requires that the lasers be used with an extremely high timing precision combined with balanced power output. Any failure in these parameters produces implosion pressure imbalances, resulting in matter ejection, thus preventing fusion ignition.

When fusion ignition is achieved, the resulting plasma of hydrogen plus fusion products, with a temperature of hundreds of millions degrees, is contained with a magnetic bottle to enable the fusion process to continue. Each component of this system, the lasers, the control systems

and magnetic bottle, are very large and expensive. Current systems would cost tens of billions of dollars, and sustained fusion has never been achieved, despite decades of work, thereby resulting in no commercially available fusion reactors at the present time.

Tokomak reactors are also known which produce a torus of plasma within a magnetic toroid. Again, high pressures and temperatures have foiled sustained operation and these systems also involve costs of tens of billions of dollars.

Summary of the Invention

The present invention provides a method of generating energy by nuclear fusion including the steps of:

creating an imploding spherical acoustic shock wave;

directing the acoustic shock wave towards a point; and

providing a fuel at the point so that when the shock wave implodes towards the point, the fuel is increased in temperature and pressure so as to cause fusion between atoms of the fuel, thereby producing nuclear fusion energy.

Preferably the method of generating the shock wave comprises detonating an explosive to create the shock wave.

Preferably the method includes providing a reflector so that when the shock wave creates fusion, the fusion produces energy, and an expanding acoustic shock wave which expands outwardly from the point is reflected by the reflector back towards the point, so as to implode towards said point, thereby creating a further shock wave which produces fusion as the shock wave implodes towards the point and pressurises and heats additional fuel.

The invention also provides a fusion reactor including means for producing an acoustic shock wave which implodes towards a point so that when fuel is located at the point, the fuel is caused to increase in pressure and temperature by the imploding shock wave, to thereby create nuclear fusion.

Preferably the means for producing the shock wave comprises a trigger shock wave to cause fusion to occur, and reflector means for reflecting acoustic waves expanding from the location of fusion when fusion has been created, and for reflecting the shock waves back towards the point as an imploding shock wave so as to again elevate the temperature and pressure of fuel at the point to cause fusion to occur; and

wherein the process of creating fusion by an imploding shock wave, which in turn produces an expanding shock wave, and reflecting that expanding shock wave back towards the point to create more fusion, continues so as to provide continued output of energy from the reactor.

Preferably the means for creating the trigger shock wave comprises an explosive which is detonated to create the trigger shock wave.

In one embodiment, the method includes providing a spherical reactor chamber and the explosive is provided on an external surface of the sphere so that when the explosive is detonated, a spherical shock wave is created which implodes towards the centre of the sphere. In another embodiment, a reactor chamber in the shape of an ellipsoid is provided which defines two focal points and the explosive is located at one of the focal points, so that when the explosive is detonated, a shock wave is created which is focused by the ellipsoidal reactor chamber to produce an imploding spherical shock wave which implodes towards the other focal point of the ellipsoid

reactor chamber. In this embodiment, the ellipsoid chamber may be in the form of two hemi-ellipsoidal chambers separated by a flat wall located at the semi-minor axis of the ellipsoid chamber. In this arrangement, one of the hemi-ellipsoid chambers is filled with fuel and the other contains the spherical explosive at the focal point, so that when the explosive is detonated, a shock wave is created which reflects from the reactor chamber to produce the imploding spherical shock wave which implodes towards the other focal point of the ellipsoid reaction chamber.

In a still further embodiment, fusion may be generated in a hemi-ellipsoid reaction chamber by placing that reaction chamber which contains fuel, in side-by-side relationship with a hemi-ellipsoid chamber in which a pulsating fusion reaction is already occurring, so that the creation of a shock wave is reflected by the ellipsoid reactor formed from the two hemi-ellipsoid chambers, so that a shock wave is focused and implodes towards the focal point of the hemi-ellipsoid chamber containing the fuel, to cause fusion to occur as the shock wave implodes towards that focal point.

Preferably the means for reflecting the shock wave comprises an internal surface of a vessel.

The invention may also be said to reside in a fusion reactor including:

a vessel having an internal surface and defining at least one focal point within the vessel, the vessel being for containing a fusion fuel;

means for creating a trigger acoustic shock wave which implodes towards said focal point, thereby causing fuel at the focal point to increase in temperature and pressure as the shock wave implodes towards the focal point, and thereby creating fusion of the fuel, and

wherein the creation of the fusion produces energy and also creates an expanding acoustic shock wave which expands outwardly from the focal point to the interior wall of the vessel from which the acoustic shock wave reflects and implodes towards said focal point, thereby again increasing the temperature and pressure of the fusion fuel at the focal point so as to again cause fusion to occur.

In one embodiment of the invention, the vessel is a sphere having the focal point at the centre of the sphere.

In another embodiment, the vessel is ellipsoid having two focal points.

In a still further embodiment, the vessel may be hemi-ellipsoidal.

The vessel may include a lens for external focusing electromagnetic radiation to a focal point.

The vessel may also include a plurality of compartments coupled together by an opening.

The compartments may be spherical or part ellipsoidal in shape.

The invention may also be said to reside in a fusion reactor including:

a first inner vessel containing a fusion fuel, the sphere being formed from a material which is transparent to at least part of the electromagnetic radiation spectrum, but which is able to reflect an acoustic shock wave created in the inner vessel;

a second intermediate vessel surrounding the inner vessel and suspension means for suspending the inner vessel within the intermediate vessel, so that when an

acoustic shock wave is generated within the inner vessel, the acoustic shock wave is not substantially transmitted to the exterior of the intermediate vessel, the intermediate vessel being formed from a material which is transparent to at least part of the electromagnetic radiation spectrum;

an outer vessel containing the intermediate vessel and the inner vessel, the volume between the intermediate vessel and the outer vessel containing a medium, the inner surface of the outer vessel being formed from a heat absorbing material so that electromagnetic radiation which is generated in the inner vessel is received by the outer vessel, to heat the inner surface of the outer vessel and therefore the medium in the volume between the intermediate vessel and the outer vessel to generate power; and

wherein fusion is generated within the inner vessel by an acoustic spherical shock wave which implodes towards a focal point of the inner vessel to elevate the temperature and pressure of the fuel in the inner vessel at the focal point to cause fusion to occur and, upon the creation of a fusion event, a shock wave is generated which expands outwardly from the focal point to be reflected back as an imploding shock wave from the inner vessel to again cause fuel at the focal point to create a further fusion reaction.

Preferably the space between the second intermediate vessel and the first intermediate vessel is a vacuum.

Brief Description of the Drawings

Preferred embodiments of the invention will be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a diagram illustrating the concept of the present invention;

Figure 2 is a view of a reactor according to one

embodiment of the invention;

Figure 3 is a view of the reactor of Figure 2, further illustrating the concept of the embodiment of Figure 2;

Figure 4 is a view of a reactor according to a still further embodiment of the invention;

Figure 5 is a view of a reactor according to another embodiment of the invention;

Figure 6 is a view of a reactor of yet a further embodiment of the invention;

Figure 7 is a view of a reactor of a still further embodiment of the invention;

Figure 8 is a view of yet another reactor according to another embodiment of the invention;

Figure 9 is a view of a reactor according to a still further embodiment of the invention;

Figure 10 shows one preferred implementation of a fusion reactor using the principles of the reactors described with reference to the earlier embodiments; and

Figure 11 shows a further embodiment of the invention.

Description of the Preferred Embodiment

With reference to Figure 1, the method of generating nuclear fusion according to the preferred embodiment of the invention is illustrated, as is a reactor according to one embodiment of the invention.

In this embodiment, the reactor comprises a spherical vessel 2 which contains a fusion fuel. The fusion fuel may be deuterium and/or tritium, but may also include heavier atoms and indeed, may simply be air because of the extreme temperatures and pressures which will be created according to the invention. These extreme temperatures are sufficient to cause fusion of heavier atoms, and therefore the preferred embodiments eliminate the need for specialised fuels such as deuterium and tritium, and

therefore reduce costs.

The vessel 2 is preferably formed from titanium. However, other materials which provide a high temperature differential against an external medium such as air or water could also be used. This in turn allows for high efficiency energy conversion. Titanium also has the advantage of high strength (allowing high fuel pressures, thus higher fuel density, thereby allowing smaller reactor size), and excellent corrosion properties.

As will be made more clear in relation to the embodiment of Figure 10, the reactor may also include transparent material such as glass, which allow for direct radiation of electromagnetic radiation, whilst reflecting back acoustic shock waves, as will be made clear hereinafter. The wall of the vessel may also include a lens, thereby allowing focusing of electromagnetic radiation to a location outside the vessel.

The vessel 2 is coated with an explosive layer 1 of any desirable explosive material. The explosive layer 1 is detonated and upon detonation of the explosive layer 1, the entire sphere of the explosive layer 1 explodes substantially simultaneously, thereby creating an acoustic shock wave which expands outwardly from the vessel, and also an imploding shock wave 3 which implodes through the vessel and into the interior of the vessel.

Figure 1 is a sequence of drawings showing how the vessel 2 and the explosive layer 1 is used to create nuclear fusion, and the sequence of operation is as per the arrows A, B, C, D, E, F, C, D, E, F, C, etc., as shown in Figure 1.

The spherical shock wave 3 which is generated upon detonation of the explosive layer 1, continues to implode

as shown by reference 4, until the imploding shock wave approaches the focal point of the vessel 2, as shown by reference 5 in Figure 1. As the shock wave implodes towards the focal point, the shock wave pressurises and heats the material within the vessel at the vicinity of the focal point to an enormously high temperature and pressure sufficient to create nuclear fusion of the atoms at that location to occur. As soon as fusion occurs, a release of energy is created which in turn creates a further shock wave which expands outwardly from the focal point is shown by reference 6 in Figure 1. That shock wave expands, as shown by reference numeral 7, until it contacts the internal wall of the vessel 2 from which it is reflected to again provide an imploding spherical shock wave, as shown by reference numeral 4 in Figure 1. The shock wave 4 implodes, as shown by reference numeral 5, towards the focal point to again cause nuclear fusion to occur. This in turn creates a new shock wave 6 and this procedure continues to repeat itself so that an oscillating shock wave which implodes down towards the focal point of the vessel 2 to create fusion is produced, and then the fusion creates a new shock wave which expands outwardly to be reflected from the internal surface of the vessel 2, so that it is again implodes towards the point to create further fusion to occur. The amount of fusion which occurs is relatively small, but the oscillating effect referred to above causes fusion of the fuel in the vessel to occur continuously, thereby creating significant energy release which is provided from the vessel 2 in the form of heat which can be used to heat the material surrounding the vessel, or which can otherwise be harnessed in the same manner as in conventional fission reactors.

The enormous temperatures which are created at the focal point of the vessel, and by the nuclear fusion decrease significantly as the energy is radiated outwardly from the

focal point towards the wall of the vessel 2, to such an extent that while the wall is heated to a very high temperature, it is not heated to a temperature which would melt or otherwise destroy the vessel 2. Imploding shock waves obey a third order power law. Thus, imploding a shock wave by a factor of 100 reduces the volume by a factor of 1 million. Imploding by a factor of 1000, provides a factor of 1 billion. Thus, the energy of the wave front of an acoustic wave will increase by a factor of 1 billion upon shrinking to one/one thousandths of its starting size. This corresponds to a spherical reactor having a diameter of one metre, wherein the shock wave will implode from a diameter of one metre to a diameter of one millimetre. Similarly, the energy generated from the fusion at, or very close to, the focal point will expand outwardly, thereby causing a reduction in temperature from the point of fusion towards the wall of the vessel, so that the temperature decreases significantly to a temperature which will not destroy the vessel but, at the same time, provide significant thermal energy at the surface of the vessel which can be harnessed in the manners described above.

Thus, the vessel 2 may have any desirable size but it is envisaged that a commercially productive reactor could be produced with a vessel having a diameter of about 1 metre.

The shock wave which is produced when fusion occurs, and when that wave is reflected from the surface 2, produces an oscillating wave effect which thereby forms a pulse reactor. This oscillation process has a number of significant advantages. Firstly, it allows time for fuel to refill the fusion location at which fusion occurs in the time it takes for the sonic wave to travel from the location at which fusion occurs and then be reflected back from the wall 2 towards the focal point of the vessel. Thus, fuel can dispense back to the focal point and be

available at the focal point for pressurisation and heating, without the need to provide any additional equipment to provide high pressures within the vessel, or to ensure that fuel is at the focus at the time of arrival of the next shock wave. Furthermore, the fusion power can be controlled by the sphere size, as the time taken for the wave to travel from the location of the fusion to the inner surface of the wall of the vessel 2, and then be reflected back towards the focus, will determine the rate at which fusion occurs within the vessel. Whilst the preferred embodiments of the invention do not require the injection of fuel into the vessel 2, or control over the gas pressure within the vessel, providing control over gas pressure by injecting or removing material from the vessel 2 provides another mechanism in which control over the fusion reaction can be achieved. The size of an opening (not shown) to provide fuel, such as air or other suitable gas, into the vessel 2, or remove gas from the vessel 2, to control the gas pressure within the vessel would be extremely small and in the order of a capillary size tube, thereby not in any way significantly reducing or impairing the spherical shock wave which is reflected from the inner surface of the vessel.

Furtherstill, the implosion of the shock wave will maintain fusion for a short time until a decreasing temperature and pressure of the expanding shock wave can no longer maintain fusion. In this time period, electromagnetic radiation which is created when fusion occurs, can reflect from the interior surface of the vessel, back towards the focal point of the vessel to reinforce the energy of the fusion event, thereby increasing the total amount of fusion occurring during each fusion event. It should be noted that the time taken for the electromagnetic radiation to reach the inner surface of the vessel and be reflected back is minuscule, compared to the time the shock wave takes to reach the

surface of the vessel and to be reflected back, and therefore before any fusion event stops and is restarted by the next imploding shock wave, the reflected electromagnetic radiation may well facilitate maintenance of the fusion event slightly longer, thereby increasing the amount of energy which is created.

Figures 2 and 3 show a second embodiment of the invention, in which the vessel 8 is ellipsoidal in shape. This provides two focal points 10 within the vessel 8, as identified by the rays 9 shown in Figure 2.

In this embodiment, the trigger wave which generates the first fusion reaction can be created by detonating a sphere of explosive which is located at one of the focal points 10. When that explosive is detonated, a shock wave is created which, as is shown by the rays 9 in Figure 2, cause a spherical shock wave 11 to implode towards the other focal point 10. As the shock wave implodes towards the other focal point 10, fuel in the vessel at the vicinity of that focal point is heated and pressurised in the same manner as in the earlier embodiment to cause fusion to occur. As in the previous embodiment, when fusion does occur, it causes a shock wave to be generated which expands outwardly to be reflected from the wall of the vessel to implode as a spherical shock wave 12 towards the other focal point 10 to create fusion at that focal point. This process continues as in the earlier embodiment.

In Figure 4, the vessel 13 has a hemi-ellipsoidal shape which is closed by a wall 14. This provides one focal point 15 within the vessel 13 and a virtual focal point 16 outside the vessel. In this embodiment, the trigger wave is created by detonating a spherical explosive charge at the focal point 15 which causes shock waves to expand outwardly from the point 15. The shock wave is reflected

by the interior wall of the hemi-ellipsoid 13 towards the virtual focal point 16. However, because of the location of the wall 14, the shock wave is reflected back from the wall 14, as shown in Figure 4, to focus as an imploding spherical wave at the focal point 15 to cause a further fusion reaction at the focal point 15. This fusion reaction creates a further shock wave and the process continues in the same manner as described above.

Creating the trigger shock wave by a sphere of explosive at the focal point in this embodiment has the disadvantage of possibly contaminating fuel which is contained in the ellipsoid vessel 8. Other methods of creating the shock wave in an ellipsoidal or hemi-ellipsoidal vessel will be described in more detail with reference to Figures 5 to 8.

The vessel shown in Figure 5 is similar to that shown in Figure 2, except that the vessel is divided into two compartments 18 and 20 by walls 19, so as to effectively provide two reactor compartments within the vessel. Thus, the compartment 18 is formed by hemi-ellipsoidal wall 18a, and one of the walls 19 and the compartment 20 by hemi-ellipsoid wall 20a and the other of the walls 19. In this embodiment, the trigger shock wave may be created by a spherical explosive charge at the focal point in the chamber 20 (for example). The shock wave is transmitted through the wall 19 and implodes as a spherical shock wave at the focal point of the chamber 18, thereby causing the fusion reaction to occur in the manner described above. If the compartment 18 and 20 are in fact separate compartments, each having a wall 19 which is in side-by-side relationship, one of the compartments, for example the compartment 20, could be completely removed and replaced by a new compartment having new fuel, so that when the new compartment is in place, the shock wave transmitted through the walls 19 will collapse as a spherical shock wave at the focal point in the compartment

20, thereby causing the fusion reaction to occur in the manner described above. It should be noted that whilst one of the compartments is removed, fusion occurs in the other compartment, in the manner described with reference to Figure 4. It should be noted that the products of the explosion which created the initial trigger shock wave are contained in the compartment 20 and do not pass through the walls 19 to the compartment 18. Thus, the fuel in the compartment 18 is clean. If the compartment 20 is completely removed and replaced by a new compartment 20 containing clean fuel, then a configuration of the type shown in Figure 3 is provided, except that walls 19 are in place. If both walls 19 are removed, than a purely ellipsoidal vessel of the type shown in Figure 3 is provided in which fusion reactions incur alternatively at each focal point in the vessel. It should also be noted that the compartment 20 need not be completed by a wall 19 and could simply be formed by the ellipsoidal wall 20a, which has an open end so that, when the compartment 20 is located adjacent the compartment 18, as shown in Figure 5, the two compartments 20 and 18 are separated by the wall 19 of the compartment 18. The compartment 20 would then simply serve to provide initial explosion which creates the trigger shock wave, and the ellipsoidal wall 20a is removed and can be replaced by another ellipsoidal wall, or a sealed compartment including the wall 20a and a flat wall 18. Thus, this enables the fusion reaction to be triggered in a vessel of the type described in Figure 3, without the vessel 2 being contaminated with the explosive residue which results after the trigger shock wave is created.

In the embodiment of Figure 6, the vessel has the same shape as in Figure 4, except that the wall 14 is replaced by a lens 23 (transparent to electromagnetic radiation) which serves to focus energy to a focal point 25 outside the vessel. The lens 23 has a planer inner surface which

forms a wall similar to the wall 19 previously described. However, in this embodiment, when the fusion reaction occurs from the focal point 22, electromagnetic radiation produced as a result of the reaction and which impinges on the lens 23, will be focused to focal point 25, thereby focusing the energy produced by the reactor to the point 25. The focused energy could be used for heating or otherwise harnessed to provide power. The acoustic shock wave which is generated when the fusion reaction takes place is reflected from the ellipsoidal inner surface of the compartment 21, and also from the planer wall of the lens 23 in the same manner as the embodiment of Figures 4 and 5, so as to again implode as a collapsing spherical shock wave at the focal point 22 to cause the next fusion reaction to occur. Once again, this process continues as fusion occurs and creates a shock wave which in turn creates the next fusion event.

Figures 7, 8 and 9 show vessel configurations which are formed by a number of compartments, each having a shape similar to the shapes previously described. In this embodiment, the compartments are joined together by openings 28.

In Figure 7, it will be appreciated that the two hemi-ellipsoidal compartments are arranged with their "apex" adjacent one another, and with the opening 28 formed at the apex. In this embodiment, shock waves are triggered simultaneously at the two focal points 27, and will be reflected from the ellipsoidal surfaces and also the end walls 26 to implode as spherical shock waves back to the focal points 27. In this embodiment, it should be noted that the opening 28 enables part of the shock wave created by one of the focal points 27 to pass through the opening 28 to the other focal point, which will complete the spherical shock wave imploding at that focal point, and the shock wave created from the other focal point 27 will

have part of the spherical shock wave pass through the opening 28 to complete the imploding shock wave imploding towards the other focus 27. As is shown by the ray diagrams in Figure 7.

In the embodiment of Figure 8, the arrangement is the same as in Figure 7, except that one of the compartments is fully ellipsoidal in configuration and includes a wall 29. Alternatively, the ellipsoid chamber could be formed by two separate hemi-ellipsoidal chambers 30 and 31. In this embodiment, the wall 29 is at least partially transparent to electromagnetic radiation and/or the shock wave so that when the fusion reaction occurs at the focal point 27 in the chamber 31, radiation and/or the acoustic shock wave is able to pass through the wall 29 to be focused at focal point 32 in the compartment 30. The compartment 30 can be used to contain hazardous or toxic materials which need to be disposed of and, by focusing electromagnetic energy at the location 32, material which is present at that location will be destroyed. As the reactions continue to occur, all of the material in the compartment 30 can be completely destroyed.

Figure 9 shows an arrangement in which three spherical vessels of the type described with reference to Figure 1 are provided, each having an opening 28 which communicates from an adjacent vessel, and when the openings 28 are arranged on a common diametric line passing through the focal points 27 of each of the chambers. In this embodiment, fusion events and shock waves concurrently occur at each of the focal points 27, and when a shock wave is created, the shock wave will travel outwardly to the inner surface of the respective spherical vessel to reflect back towards the focal point 27. However, the part of the shock wave which reaches the opening 28 will simply pass through the opening 28 and will form part of the spherical shock wave which is imploding towards the

focal point 27 of the adjacent vessel. Thus, the imploding spherical shock waves are formed mostly by reflected shock waves from the interior surface of the respective compartment, and partly by a small amount of the shock wave which passes through the opening 28 and effectively joins with the reflected part of the shock wave, to complete the spherical shock wave which implodes to each of the focal points 27.

Figure 10 shows one practical arrangement of a reactor according to an embodiment of the invention which uses the principles described above and, in particular, the spherical form of the reactor described with reference to Figure 1. In this embodiment, an inner spherical vessel 29 is filled with a fuel 32 and the vessel 29 is formed from a transparent material such as glass. The vessel 29 is suspended in a further spherical vessel 30 by springs 33. The vessel 30 is also formed from transparent material such as glass. The vessels 29 and 30 are located in a further titanium vessel 31, which has a black inner surface and the volume between the vessel 30 and the inner surface of the wall of the vessel 31 is filled with a medium such as water. The vessel 29 forms a pulse reactor which operates in the manner described with reference to Figure 1. The region between the vessels 29 and 30 is a vacuum and the vacuum in that region, together with the springs 33 provides acoustic isolation of the vessel 29 so that the acoustic shock wave which is created when the fusion event occurs is not transmitted to the exterior of the vessel 30. Electromagnetic radiation which is generated when the fusion event occurs, radiates through the transparent vessels 29 and 30 to be absorbed on the surface of the vessel 31 to thereby directly heat the water 34 within the space between the vessel 30 and the inner surface of the vessel 31. Thus, the volume between the vessels 30 and 31 acts as a steam generator with the water in that region being heated to generate steam which

can be used for any desired purpose, such as a steam turbine generator.

If, in a worst case scenario, the water jacket surrounding the vessel 30 is lost, and the reactor overheats, the vessel 29 would melt or disintegrate first, resulting in distortion of the expanding spherical wave created by the last fusion event, which in turn, would deform the implosive wave reflected from the melting or collapsing vessel 29, thereby rapidly lowering the implosion efficiency and thereby stopping the fusion reaction from continuing. Repairs would be limited to replacement of the vessel 29.

Figure 11 shows a still further embodiment of the invention in which the vessel is in the shape of a tube 50 having hemi-spherical ends 52 and 54. In this embodiment, a trigger shock wave could be generated by coating the exterior of the vessel 50 with an explosive which is detonated in the same manner as the embodiment described with reference to Figure 1. However, in this embodiment, the imploding shock waves will implode in planes which are perpendicular to the axis of the tubular vessel 50, towards a line 53 centrally or axially of the vessel 50. However, it should be noted that if the ends 52 and 54 are coated with an explosive material, they will create a hemi-spherical shock wave which will implode towards the focal points of those hemi-spherical ends which are represented by the end points of the line 53 drawn in Figure 11. In this embodiment, the imploding shock wave will obey a second order power law, rather than a third order power law, as in the earlier embodiments, and therefore it may be necessary to make the tube significantly larger than the spherical or ellipsoid configurations previously described, to ensure that the imploding shock wave contains enough energy when it implodes towards the line 53 to generate the heat and

pressure required for fusion.

In still further embodiments, other shapes such as a torus, double helix, or the like, could also be used and which would operate in the same manner as described with reference to Figure 11.

As previously mentioned, energy from the reactor according to the preferred embodiments of the invention can be obtained in a similar manner to that which occurs in conventional fission reactors. That is, the fusion reactor produces heat. A similar steam turbine electric power generation system to that which is used in conventional fission nuclear reactors or fuel burning power stations can therefore be used. However, the primary heat exchange system and most safety systems, including the containment building, needed in fission reactors will not be required.

The generation of the acoustic shock waves used in the invention can create powerful vibrations. These vibrations can directly produce an alternative type of direct and/or supplemental power source. These acoustic power sources do not require the steam turbine electric system, and are cheap, compact and easy to implement.

Applications of the acoustic shock waves include air, gas or liquid compressor and/or pump installations, piezo or inductive electric power generation, and poly-phase systems can be implemented either by using several frequency locked fusion reactors or by creating acoustic delays, such as by adding a simple steel bar or spring.

The adjustment of the amount of power obtained from the reactor can be achieved by varying the gas pressure within the reactor, varying the gas composition, mechanically varying the inner acoustically reflective surface to

control the amount of energy reflected to the focal points within the reactor, and frequency adjustment can include mechanically varying the inner acoustic reflective surface to control the timing of energy reflected to the focal point and altering the external pressure around the fusion reactor for very fine control, as per that required for various low phase adjustments.

Control methods may further include providing a larger vessel which would have a lower oscillation frequency, but would accommodate stronger fusion events, lessening the amount of acoustic energy in the imploding shock wave by the use of absorbent materials will lessen the amount of fusion, utilising supplemental inbound electromagnetic radiation, the use of a particular fuel, for example, lighter elements will undergo fusion more easily, and modifying the fuel composition will modify the reaction, increasing the fuel pressure to produce a stronger reaction, and wherein the increased fuel pressure can slightly effect the oscillation frequency, and lessening the amount of acoustic energy in the imploding shock wave by external coupling will lessen the amount of fusion.

The reactor may be used for conventional power generation in the sense of producing heat which will turn a turbine, etc. as described above, or could be used in direct applications such as:

aircraft propulsion systems;

spacecraft propulsion;

heat exchange propulsion type systems for use in trains, trucks, cars, and shipping, and the like.

Since modifications within the spirit and scope of the invention may readily be effected by persons skilled within the art, it is to be understood that this invention is not limited to the particular embodiment described by way of example hereinabove.

Claims

1. A method of generating energy by nuclear fusion including the steps of:

creating an imploding spherical acoustic shock wave;

directing the acoustic shock wave towards a point; and

providing a fuel at the point so that when the shock wave implodes towards the point, the fuel is increased in temperature and pressure so as to cause fusion between atoms of the fuel, thereby producing nuclear fusion energy.

2. The method of claim 1 wherein the method of generating the shock wave comprises detonating an explosive to create the shock wave.

3. The method of claim 1 wherein the method includes providing a reflector so that when the shock wave creates fusion, the fusion produces energy, and an expanding acoustic shock wave which expands outwardly from the point is reflected by the reflector back towards the point, so as to implode towards said point, thereby creating a further shock wave which produces fusion as the shock wave implodes towards the point and pressurises and heats additional fuel.

4. A fusion reactor including means for producing an acoustic shock wave which implodes towards a point so that when fuel is located at the point, the fuel is caused to increase in pressure and temperature by the imploding shock wave, to thereby create nuclear fusion.

5. The reactor of claim 4 wherein the means for producing the shock wave comprises a trigger shock wave to cause fusion to occur, and reflector means for reflecting

acoustic waves expanding from the location of fusion when fusion has been created, and for reflecting the shock waves back towards the point as an imploding shock wave so as to again elevate the temperature and pressure of fuel at the point to cause fusion to occur; and

wherein the process of creating fusion by an imploding shock wave, which in turn produces an expanding shock wave, and reflecting that expanding shock wave back towards the point to create more fusion, continues so as to provide continued output of energy from the reactor.

6. The reactor of claim 5 wherein the means for creating the trigger shock wave comprises an explosive which is detonated to create the trigger shock wave.

7. The reactor of claim 5 wherein the trigger shock wave is created by providing an explosive on an external surface of a spherical vessel and detonating the explosive so as to create an imploding spherical shock wave.

8. The reactor of claim 5 wherein the trigger shock wave is generated by locating the explosive at one focal point of a reactor which has at least two focal points, and wherein the shock wave is reflected from the reactor and collapses the spherical shock wave at, at least one other focal point in the reactor to create fusion at that focal point.

9. The reactor of claim 6 wherein the means for reflecting the shock wave comprises an internal surface of a vessel.

10. A fusion reactor including:

a vessel having an internal surface and defining at least one focal point within the vessel, the vessel being for containing a fusion fuel;

means for creating a trigger acoustic shock wave

which implodes towards said focal point, thereby causing fuel at the focal point to increase in temperature and pressure as the shock wave implodes towards the focal point, and thereby creating fusion of the fuel, and wherein the creation of the fusion produces energy and also creates an expanding acoustic shock wave which expands outwardly from the focal point to the interior wall of the vessel from which the acoustic shock wave reflects and implodes towards said focal point, thereby again increasing the temperature and pressure of the fusion fuel at the focal point so as to again cause fusion to occur.

11. The reactor of claim 10 wherein the vessel is a sphere having the focal point at the centre of the sphere.

12. The reactor of claim 10 wherein the vessel is ellipsoid having two focal points.

13. The reactor of claim 10 wherein the vessel is hemi-ellipsoidal.

14. The reactor of claim 10 wherein the vessel includes a lens for focusing electromagnetic radiation to a focal point exterior of the vessel.

15. The reactor of claim 10 wherein the vessel includes a plurality of compartments coupled together by an opening.

16. The reactor of claim 15 wherein the compartments are spherical or part ellipsoidal in shape.

17. The reactor of claim 10 wherein the means for creating the trigger shock wave comprises an explosive which is detonated to create the trigger shock wave.

18. The reactor of claim 17 wherein the trigger shock wave is created by providing an explosive on an external surface of a spherical vessel and detonating the explosive so as to create an imploding spherical shock wave.

19. The reactor of claim 17 wherein the trigger shock wave is generated by locating the explosive at one focal point of a reactor which has at least two focal points, and wherein the shock wave is reflected from the reactor and collapses the spherical shock wave at, at least one other focal point in the reactor to create fusion at that focal point.

20. The reactor of claim 10 wherein the vessel has a tubular configuration and a plurality of focal points are contained on a axial line of the tube.

21. A fusion reactor including:

a first inner vessel containing a fusion fuel, the sphere being formed from a material which is transparent to at least part of the electromagnetic radiation spectrum, but which is able to reflect an acoustic shock wave created in the inner vessel;

a second intermediate vessel surrounding the inner vessel and suspension means for suspending the inner vessel within the intermediate vessel, so that when an acoustic shock wave is generated within the inner vessel, the acoustic shock wave is not substantially transmitted to the exterior of the intermediate vessel, the intermediate vessel being formed from a material which is transparent to at least part of the electromagnetic radiation spectrum;

an outer vessel containing the intermediate vessel and the inner vessel, the volume between the intermediate vessel and the outer vessel containing a medium, the inner surface of the outer vessel being formed from a heat absorbing material so that electromagnetic

radiation which is generated in the inner vessel is received by the outer vessel, to heat the inner surface of the outer vessel and therefore the medium in the volume between the intermediate vessel and the outer vessel to generate power; and

wherein fusion is generated within the inner vessel by an acoustic spherical shock wave which implodes towards a focal point of the inner vessel to elevate the temperature and pressure of the fuel in the inner vessel at the focal point to cause fusion to occur and, upon the creation of a fusion event, a shock wave is generated which expands outwardly from the focal point to be reflected back as an imploding shock wave from the inner vessel to again cause fuel at the focal point to create a further fusion reaction.

22. The fusion reactor of claim 21 wherein the medium is water which is heatable to generate steam.

23. The fusion reactor of claim 21 wherein the space between the inner vessel and the intermediate vessel is a vacuum.

24. The fusion reactor according to claim 21 wherein the inner vessel, the intermediate vessel and the outer vessel are spherical vessels.

Figure 1

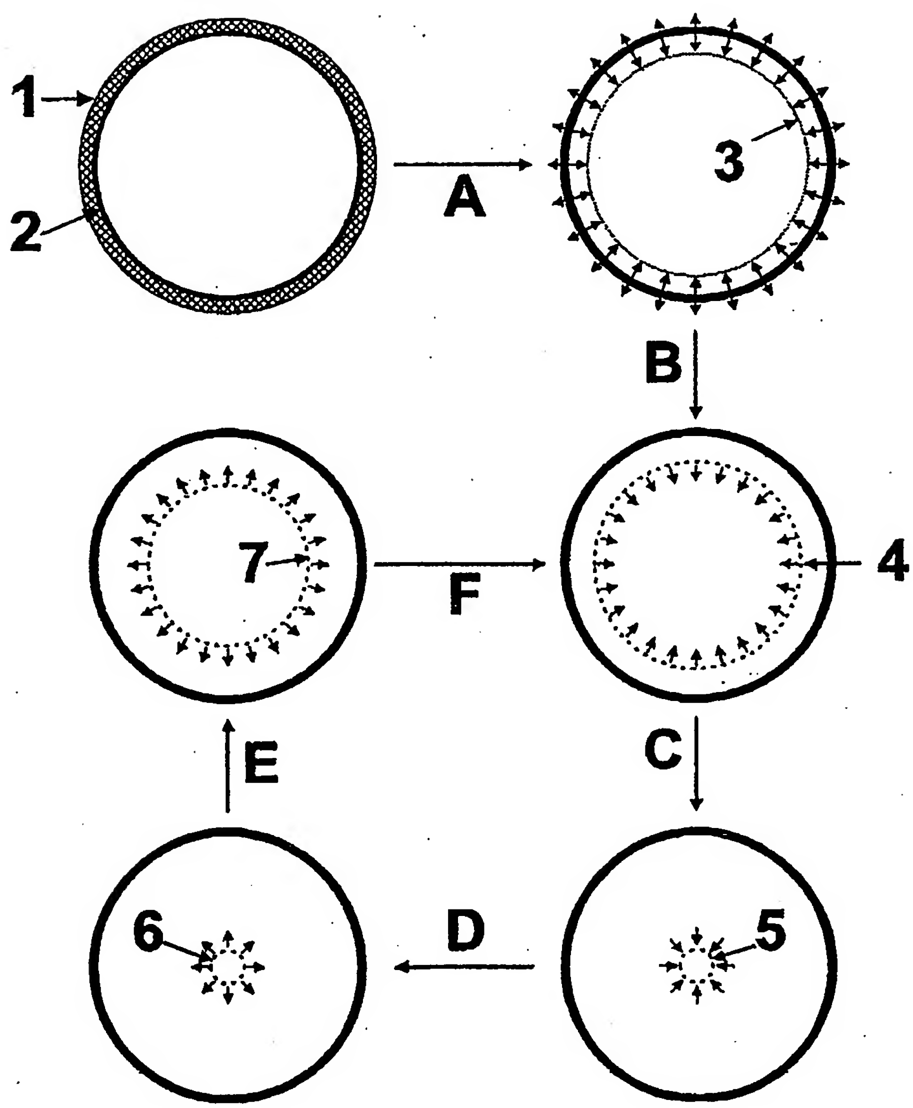


Figure 2

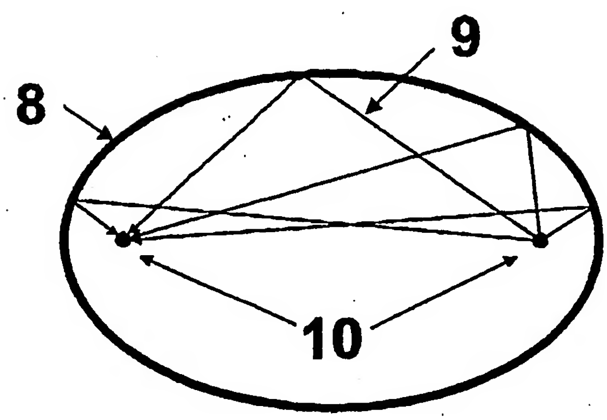


Figure 3

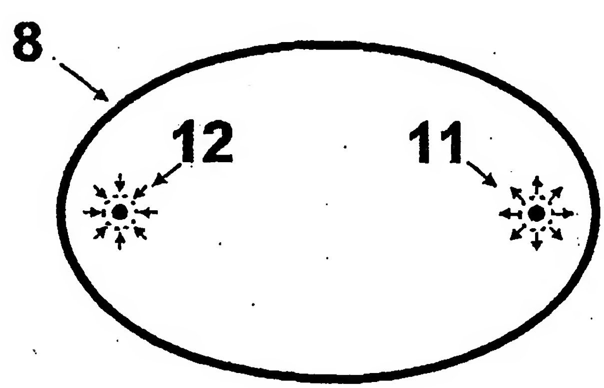
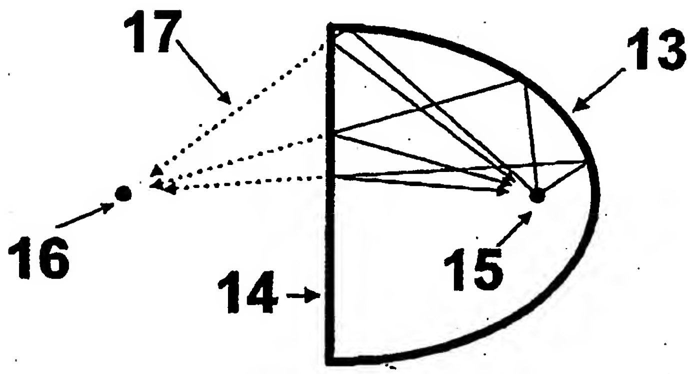


Figure 4



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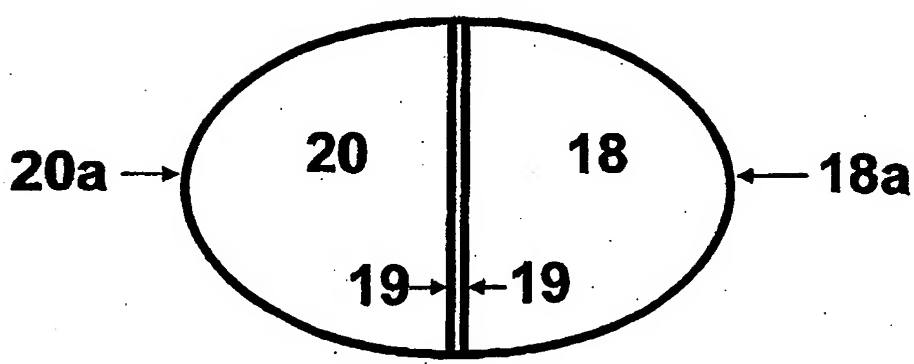

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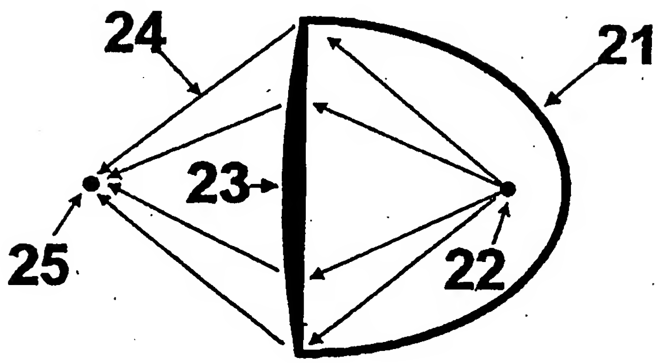

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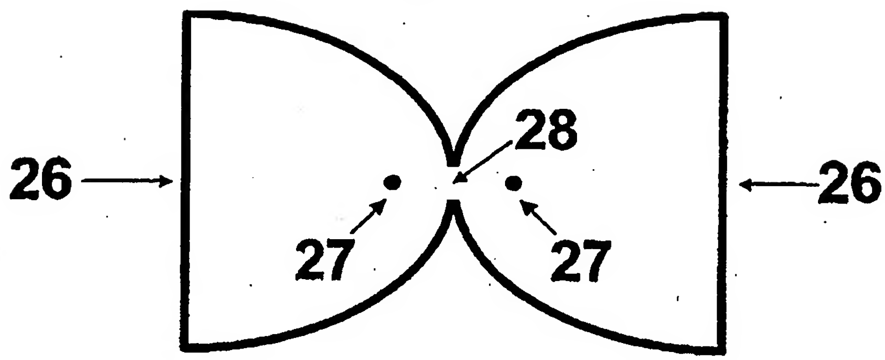
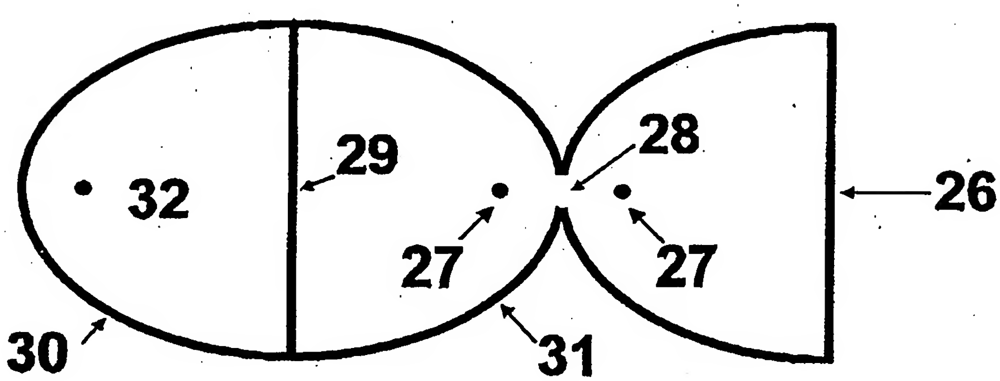


Figure 8



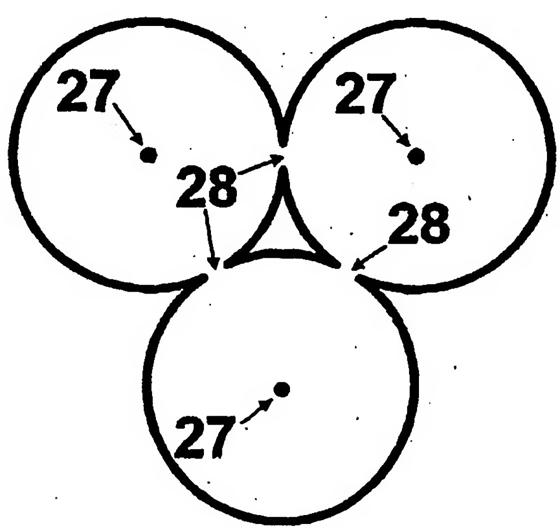


Figure 9

Figure 10

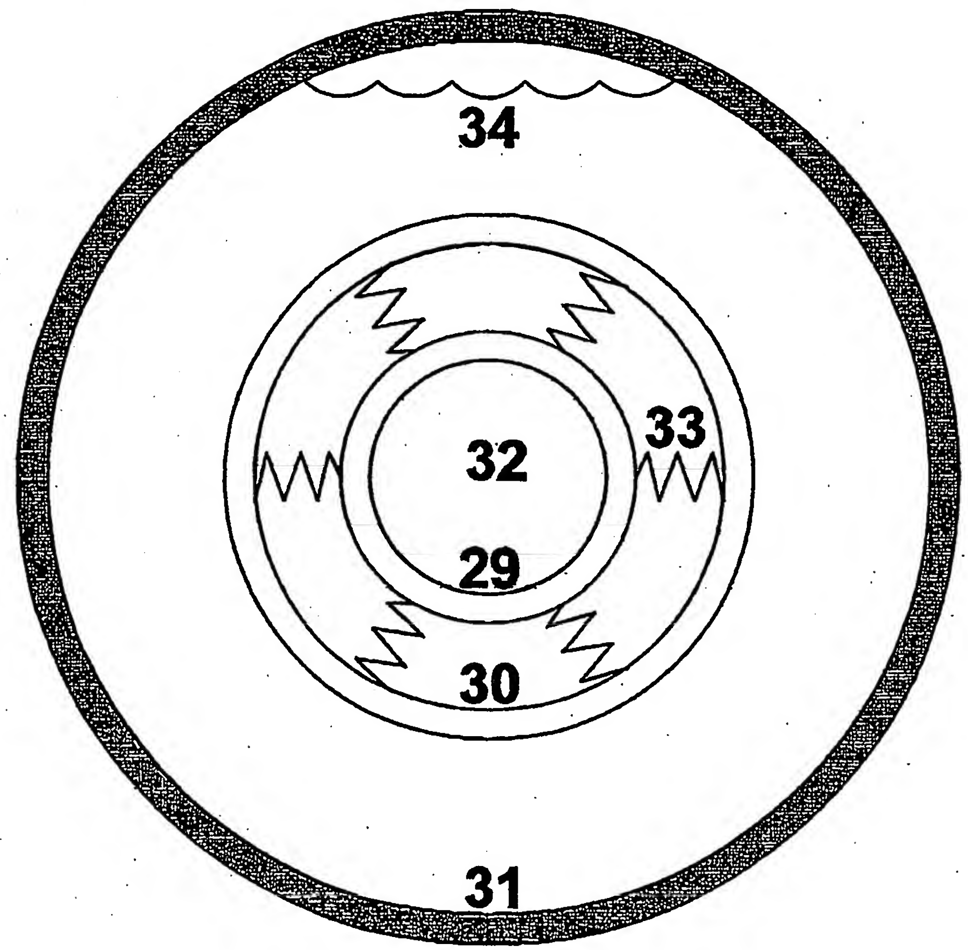
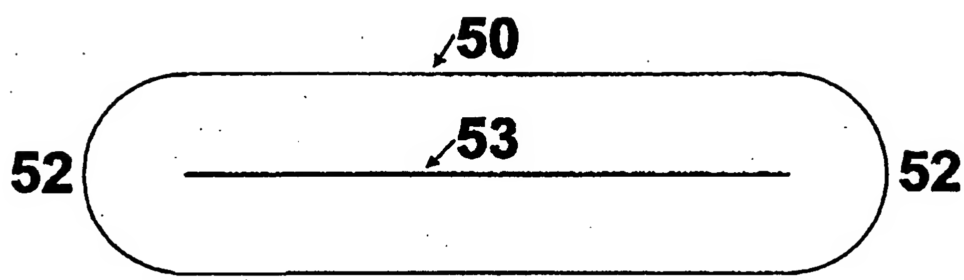


Figure 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/00314

A.	**CLASSIFICATION OF SUBJECT MATTER**
Int. Cl. 7:	G21B 1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI, JAPIO IPC G21B/IC with KEYWORDS: acoustic+ or +sound or +sonic .

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5659173 A (PUTTERMAN et al.) 19 August 1997 Col. 22, lines 19-31, Figs 13,21..	1,2,4
X	CA 2104939 A (KRAWZIK) 15 April 1995 Whole specification.	1,2,4
X	PATENT ABSTRACTS OF JAPAN, JP 05-281379 A (KUBOTA HIROSHI) 29 October 1993 Paragraph (006),Figs 1-3.	1-12, 17-20

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

* Special categories of cited documents:

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- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 May 2002	17 MAY 2002
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **M.E. DIXON** Telephone No : (02) 6283 2194

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU02/00314**

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Patent Document Cited in Search Report		Patent Family Member			
US	5659173	CA	2183248	WO	9523413
CA	2104939	NONE			
JP	5281379	NONE			

END OF ANNEX